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[Superseding IS 14774 (Part 1) : 2000]

भारतीय मानक

विस्फोटी पर्यावरण

भाग 30 इलैक्ट्रिकल रोधिता लेश ताप

अनुभाग 1 सामान्य एवं परीक्षण अपेक्षाएँ

Indian Standard

EXPLOSIVE ATMOSPHERES

PART 30 ELECTRICAL RESISTANCE TRACE HEATING

Section 1 General and Testing Requirements

ICS 29.260.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

November 2012 **Price Group 9**

Electrical Apparatus for Explosive Atmospheres Sectional Committee, ETD 22

NATIONAL FOREWORD

This Indian Standard (Part 30/Sec 1) which is identical with IEC 60079-30-1 : 2007 ‘Explosive atmospheres — Part 30-1: Electrical resistance trace heating — General and testing requirements’ issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Apparatus for Explosive Atmospheres Sectional Committee and approval of the Electrotechnical Division Council.

This standard supersedes IS 14774 (Part 1) : 2000 ‘Resistance trace heating in potentially explosive atmospheres: Part 1 General and testing’, which was based on CDV document of IEC 62086-1 : 2001 ‘Resistance trace heating in potentially explosive atmospheres: Part 1 General and testing’ (Since withdrawn by IEC and replaced by IEC 60079-30-1 : 2007).

After the publication of this standard IS 14774 (Part 1) : 2000 shall stand withdrawn.

The main technical differences in IS/IEC 60079-30-1 : 2007, apart from the general revision and updating of IS 14774 (Part 1) : 2000, are as follows:

a) Inclusion of thermal safety requirements for the manufacturer’s quality programme;
b) Inclusion of a 14 day water resistance test; and
c) Further harmonization with other national standards.

This standard is intended to be used in conjunction with IS/IEC 60079-30-2 : 2006 ‘Explosive atmospheres — Part 30-2: Electrical resistance trace heating — Application guide for design, installation and maintenance’.

This standard is intended to provide a comprehensive overview of the essential requirements and testing appropriate to electric surface heating equipment used in explosive gas atmospheres. The requirements of this standard are considered to be the minimum requirements for zone 1 or zone 2.

BIS Certification Marking is applicable to product covered under this Indian Standard, the details of which are given in National Annex A.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’.
b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, references appear to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60050(151) International Electrotechnical Vocabulary (IEV) — Part 151: Electrical and magnetic devices	IS 1885 (Part 74) : 1993 Electrotechnical vocabulary: Part 74 Electrical and magnetic devices	Identical to IEC 60050-151 : 1978

(*Continued on third cover*)

Indian Standard

EXPLOSIVE ATMOSPHERES

PART 30 ELECTRICAL RESISTANCE TRACE HEATING

Section 1 General and Testing Requirements

1 Scope

This part of IEC 60079 specifies general and testing requirements for electrical resistance trace heaters for application in explosive gas atmospheres. The standard covers trace heaters that may comprise either factory- or field- (work-site) assembled units, and which may be series heating cables, parallel heating cables or heating pads and heating panels that have been assembled and/or terminated in accordance with the manufacturer's instructions.

This standard also includes requirements for termination assemblies and control methods used with trace heating. The hazardous areas referred to by this standard are those defined in IEC 60079-10.

Where a requirement of this standard conflicts with a requirement of IEC 60079-0, the requirement of this standard shall take precedence.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050(151), *International Electrotechnical Vocabulary (IEV) – Part 151: Electrical and magnetic devices*

IEC 60079-0:2004, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60079-7:2001, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety 'e'*

IEC 60079-10:2002, *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*

IEC 60079-30-2, *Explosive atmospheres – Part 30-2: Electrical resistance trace heating – Application guide for design, installation and maintenance*

IEC 60364-5-55, *Electrical installations of buildings – Part 5-55: Selection and erection of electrical equipment – Other equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0 and IEC 60079-7 as well as the following apply.

NOTE Additional definitions applicable to explosive atmospheres can be found in IEC 60050-426[1].

3.1
ambient temperature
temperature surrounding the object under consideration. Where electrical trace heaters are enclosed in thermal insulation, the ambient temperature is the temperature exterior to such thermal insulation

3.2
branch circuit
that portion of the wiring installation between the overcurrent device protecting the circuit and the trace heater unit(s)

3.3
connections (terminations)

3.3.1
cold lead
electrically insulated conductor or conductors used to connect a trace heater to the branch circuit and designed so that it does not produce significant heat

3.3.2
end termination
termination, which may be heat producing, applied to a trace heater at the end opposite that where the power is supplied

3.3.3
power termination
termination applied to the end of a trace heater at which the power is supplied

3.4
tee
electrical connection of trace heaters, in series or in parallel, to accommodate a tee or branch

3.5
dead leg
segment of process piping segregated from the normal flow pattern for the purpose of providing a heat-loss reference

3.6
design loading
minimum power that will meet the design requirements, in the worst conditions, after voltage and resistance tolerances and appropriate safety factors have been considered

3.7
factory-fabricated
trace heaters, including the necessary terminations and connections, assembled into units or sets

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[1] IEC 60050(426), International Electrotechnical Vocabulary (IEV) – Chapter 426: Electrical apparatus for explosive atmospheres

3.8
field-assembled
trace heaters supplied in bulk with terminating components to be assembled at the work site

3.9
heat loss
energy flow from a pipe, vessel or equipment to its surroundings

3.10
heat sink
part that conducts and dissipates heat away from a workpiece

NOTE Typical heat sinks are pipe shoes, pipe supports and items of large mass such as valve actuators or pump bodies.

3.11
heat-transfer aids
thermally conductive materials, such as metallic foils or heat-transfer compounds used to increase the heat-transfer efficiency from trace heaters to the workpiece

3.12
heating pad
trace heater comprising series- or parallel-connected elements having sufficient flexibility to conform to the shape of the surface to be heated

3.13
heating panel
non-flexible trace heater comprising series- or parallel-connected elements fabricated to conform to the general shape of the surface to be heated

3.14
high-limit temperature
maximum allowable temperature of the system, including piping, fluid and heating system

3.15
maximum withstand temperature
maximum operating or exposure temperature that will not adversely effect the thermal stability of the trace heater and its component parts

3.16
metallic covering
metal sheath or braid used to provide physical protection for a trace heater, and may provide an electrical earth path

3.17
minimum ambient temperature
lowest ambient temperature specified at which heat-loss calculations are based and the trace heating is operable and performs according to the specified requirements

3.18
operating voltage
actual voltage applied to the trace heater when in service

3.19
overjacket
continuous layer of insulating material applied outside the metallic sheath, screen or armouring to protect against corrosion

3.20
parallel trace heater(s)
heating elements that are electrically connected in parallel, either continuously or in zones, so that the watt density per lineal length is maintained, irrespective of any change in length for the continuous type or for any number of discrete zones

3.21
power density
power output in watts per linear metre for trace heater cables and cable units, and in watts per square metre for trace heater pads and panels and trace heater pad and panel units

3.22
rated output
total power or power per unit length or unit surface area of a trace heater, at rated voltage, temperature and length, which is normally expressed in watts, watts per metre or watts per square metre

3.23
rated voltage
voltage to which operating and performance characteristics of trace heaters are referred

3.24
routine test
conformity test made on each individual item during or after manufacture

[IEV 151-16-17]

3.25
series trace heater(s)
heating elements electrically connected in series with a single current path and with a specific resistance at a given temperature for a given length

3.26
sheath
uniform and continuous metallic or non-metallic outer covering enclosing the trace heater used to provide protection against influence from the surroundings (corrosion, moisture etc.). See overjacket, 3.19

3.27
sheath temperature
temperature of the outermost continuous covering that may be exposed to the surrounding atmosphere

3.28
stabilized design
concept where the temperature of the trace heater will, by design and use, stabilize below the high-limit temperature, under the most unfavourable conditions, without the need for a protective system to limit the temperature

3.29
start-up current
the current response of a trace heater following energization

3.30
system documentation
information provided by the supplier to allow satisfactory understanding, installation and safe use of the trace heating system

3.31
temperature alarm device
serves to activate an alarm when the sensor temperature is outside the specified temperature range

3.32
temperature control device
serves to maintain the temperature within a specified temperature range

3.33
temperature controller
device or combination of devices incorporating a means of sensing temperature and of controlling the power to the trace heater

3.34
temperature limiting device
serves to switch off power to the trace heater to prevent the high-limit temperature exceeding the maximum permissible surface temperature, e.g. in a fault scenario

3.35
thermal insulation
material having air- or gas-filled pockets, void spaces, or heat-reflecting surfaces that, when properly applied, retards the transfer of heat

3.36
trace heater
device designed for the purpose of producing heat on the principle of electrical resistance and typically composed of one and/or more metallic conductors or an electrically conductive material, suitably electrically insulated and protected

3.37
trace heater unit
(trace heater set)
series trace heater cable, parallel trace heater cable, trace heater pad or trace heater panel suitably terminated in conformity with the manufacturer's instructions

3.38
trace heating
utilization of electric trace heater cables, pads, panels and support components, externally applied and used to raise or maintain the temperature of contents in piping, tanks and associated equipment

3.39
trace ratio
the ratio of trace heater length to pipe length

3.40
type test
conformity test made on one or more items representative of the production

[IEV 151-16-16]

3.41
weather barrier
material that, when installed on the outer surface of thermal insulation, protects the thermal insulation from water or other liquids, from physical damage caused by sleet, wind or mechanical abuse and from deterioration caused by solar radiation or atmospheric contamination

3.42
workpiece
object to which a trace heater is applied

NOTE Examples include process equipment such as piping, vessels, tanks, valves, instruments and similar equipment.

4 General requirements

4.1 General

Electrical resistance trace heating within the scope of this standard shall be designed and constructed so as to ensure electrical, thermal and mechanical durability and reliable performance so that, in normal use, it poses no danger to the user or the surroundings. Electrical resistance trace heaters and integral components shall comply with the requirements of IEC 60079-0 as supplemented and modified by the requirements of this standard. Electrical resistance trace heater terminations identified as separate components shall comply with the requirements of one or more of the types of protection listed in IEC 60079-0 suitable for the application, which may be supplemented and modified by the requirements of this standard.

Trace heaters shall be provided with a metallic braid or metallic sheath that shall cover at least 70 % of the surface.

Trace heaters which are identified for use only in areas with a low risk of mechanical damage are subjected to a reduced load in the impact test in 5.1.5 and a reduced force in the deformation test in 5.1.6, and shall be clearly marked as specified in 6.3.

Trace heaters may be supplied with additional mechanical protection to meet the requirements of this standard if they are supplied as an integral assembly (prefabricated), and that contain the following statement in the instructions: “ This mechanical covering shall not be removed and the trace heaters shall not be operated without the mechanical covering being in place”.

The manufacturer shall declare the maximum withstand temperature in degrees Celsius. The materials used in the trace heater shall withstand a temperature of no less than the manufacturer's declared maximum withstand temperature +20 K, when tested in accordance with 5.1.11.

In this standard, Clause 7 of IEC 60079-0 does not apply to electrical insulating materials of trace heaters.

4.2 Terminations and connections

Terminations and connections may be identified as an integral part of a trace heater, or may be identified separately, in which case they are regarded as Ex components in accordance with Clause 13 of IEC 60079-0. Integral terminations and connections are tested as part of a representative trace heater unit; see 5.1.1.

4.3 Circuit protection requirements for branch circuits

The minimum requirements for trace heating systems for use in explosive gas atmospheres are as follows:

a) a means of isolating all line conductors from the supply;

b) over-current protection provided for each branch circuit;

c) a means of protecting against earth faults which depend on the type of system earthing (see IEC 60364-5-55 for definitions).

For TT and TN systems using earth-fault protective devices:

d) The trace heater branch circuit protection shall be capable of interrupting high-impedance earth faults as well as short-circuit faults. This shall be accomplished by an earth-fault protective device, or a controller with earth-fault interruption capability for use in conjunction with suitable circuit protection. The preferred trip level for adjustable devices is 30 mA above any inherent capacitive leakage characteristic of the heater as specified by the trace heater supplier. Where conditions of maintenance and supervision ensure that only qualified persons will service the installed systems, and continued circuit operation is necessary for the safe operation of the equipment or processes, earth-fault detection without interruption is acceptable if alarmed in a manner to ensure an acknowledged response.

   NOTE The requirements of a), b), c) and d) may be performed by one device.

For IT systems:

e) an electrical insulation monitoring device shall be installed to disconnect the supply whenever the electrical resistance is not greater than 50 Ω/V of rated voltage.

4.4 Control and temperature requirements

4.4.1 General

A trace heating system shall be designed so that under all conditions that may reasonably be foreseen the surface temperature of the trace heaters is limited to the temperature classification or ignition temperature, less 5 K for temperatures less than or equal to 200 °C or less 10 K for temperatures greater than 200 °C. This shall be achieved either by a stabilized design in accordance with 4.4.2, or by the use of temperature control devices in accordance with 4.4.3 to limit the maximum equipment temperature.

When multiple trace heaters (especially on pipes with different flow conditions) are grouped together under a single surface-sensing temperature control device, each design condition shall be analysed as a stabilized pipe design.

4.4.2 Stabilized design for zone 1 and zone 2 applications

Stabilized design applications, in which the maximum surface temperature of the trace heater is determined without thermostatic control, shall employ either the systems approach specified in 5.1.13.2 or the product classification approach specified in 5.1.13.3.

4.4.3 Controlled design

Controlled design applications, which require the use of a temperature control device to limit the maximum surface temperature, shall comply with a) for zone 1 and either a) or b) for zone 2:

a) for zone 1 applications: a protective device such as a temperature limiter shall be provided that will de-energize the system to prevent exceeding the maximum permissible surface temperature. In case of an error by, or damage to the sensor, the heating system shall be de-energized before replacing the defective equipment. The protective device shall operate independently from the temperature controller. The protective device shall have the following characteristics:

   1) Resetting by hand only
   2) Resetting possible only after the normal operating conditions have returned, or if the switching state is monitored continuously
   3) Tool or keyed lock required for resetting
   4) Temperature setting secured and locked to prevent manipulation
   5) A control that will de-energize the circuit if the sensor fails

b) for zone 2 applications: a single temperature controller with failure announcement may be used. If so, provision of adequate monitoring of such an announcement, such as 24 h surveillance, shall be made.

NOTE If the control devices are not being provided by the manufacturer, sufficient instructions for selection and installation should be provided.

5 Testing

5.1 Type tests

5.1.1 General

The provisions of 26.1 of IEC 60079-0 apply with the following additions. Samples of trace heaters at least 3 m in length, unless otherwise specified, shall be selected for testing. Tests shall be conducted at a temperature between 10 °C and 40 °C unless otherwise stated. Terminations and connections that are to be installed as an integral part of the trace heater, whether intended to be factory fabricated or field assembled, shall be subjected to the same tests as the trace heater, except where otherwise noted. These connections shall include end terminations, tees, in-line splices and power terminations, as well as glands, fittings and seals where a trace heater enters a termination enclosure.

5.1.2 Dielectric test

The dielectric test shall be performed in accordance with Table 1 on test sample(s) prepared as described in 5.1.1.

Table 1 – Test voltages for the dielectric test

Rated voltage	Test voltage V a.c. (r.m.s.)
< 30 V a.c. (r.m.s.)	500
< 60 V d.c.	500
≥ 30 V a.c. (r.m.s.)	$2\,U + 1\,000$
≥ 60 V d.c.	$\sqrt{2}\,U + 1\,000$

The test voltage, where *U* is the rated voltage, shall be applied between the conductors and the metallic braid or sheath at a rate of rise of neither less than 100 V/s nor more than 200 V/s and maintained for 1 min without dielectric breakdown. The test voltage waveform shall be essentially sinusoidal, with a frequency of 45 Hz to 65 Hz.

When determining *U*, the correct use of Phase to Phase or Phase to Neutral voltage levels shall be considered.

5.1.3 Electrical insulation resistance test

The electrical insulation resistance test shall be conducted after the dielectric test specified in 5.1.2 on the same test sample(s). The resistance of the electrical insulation shall be measured between conductors and the metallic outer covering, or a specially applied conductive metal tape or braid, by means of a d.c. source voltage (nominal) of 500 V. The measured value shall be not less than 50 MΩ.

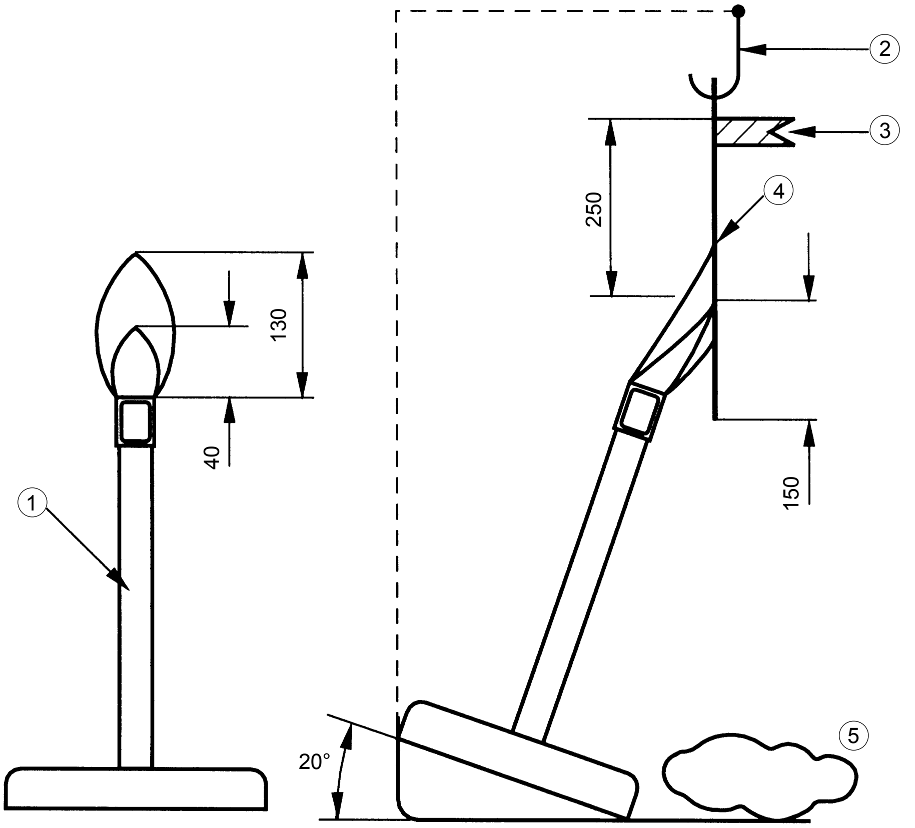
5.1.4 Flammability test

A flammability test shall be performed on all trace heaters, including those that are supplied within a prefabricated integral assembly. The test shall be made in a room free from draughts. The sample trace heater at least 450 mm in length shall be supported in a vertical position. For pads, panels and other trace heaters, the sample width shall be 80 mm.

A gummed unbleached paper indicator shall be wrapped once around the sample so that it projects 20 mm from the sample. The paper indicator shall be positioned 250 mm above the point at which the inner blue cone of the flame contacts the sample. A layer of dry, pure surgical cotton not more than 6 mm in depth shall be placed underneath the sample so that the distance from the cotton to the point of the flame application is 250 mm.

The height of the natural gas flame of the burner shall be adjusted to 130 mm with an inner blue cone 40 mm high, as shown in Figure 1a. The burner shall be tilted to an angle of 20° and the flame applied so that the tip of the inner blue cone of the flame touches the specimen at the point approximately 150 mm above its lower end. The flame shall be brought up to the trace heater in such a manner that the vertical plane containing the major axis of the burner tube is at right angles to the plane of the sample being tested as shown in Figure 1b. The flame shall be applied for 15 s, then removed for 15 s, until five such applications have been made.

The test results shall be considered satisfactory if the trace heater does not support combustion for more than 1 min after the fifth application of the flame, does not burn more than 25 % of the extended unbleached paper and does not ignite the cotton with falling, burning particles.



Key

1 burner	4 test sample
2 support	5 dry pure surgical cotton
3 unbleached paper flag	*Dimensions in millimetres*

Figure 1a – Height of natural gas flame

Figure 1b – Vertical plane at right angles to sample under test

Figure 1 – Flammability test

5.1.5 Impact test

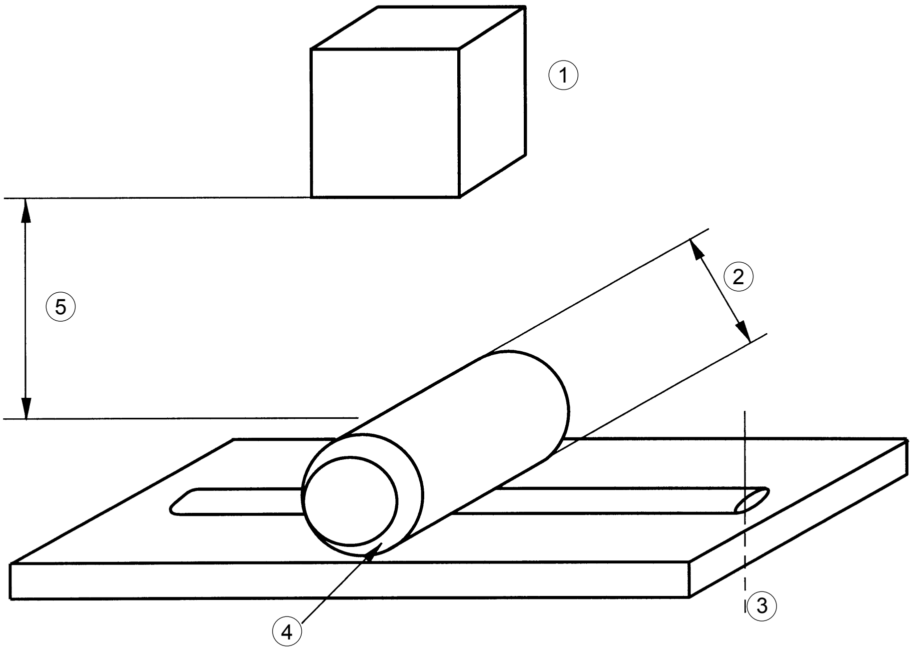
NOTE Electric trace heaters are, in the majority of applications, covered by thermal insulation and therefore afforded some mechanical protection. In some applications, however, trace heaters may be installed under conditions where they will not always be protected by thermal insulation; for example, during installation before the thermal insulation is applied or where the trace heater exits from the thermal insulation into a junction box.

A sample approximately 200 mm in length is placed on a rigid flat steel plate and positioned underneath an intermediate piece of hardened steel in the shape of a horizontal cylinder with a diameter of 25 mm. This cylinder is required to have a length of 25 mm with smoothly rounded edges to a radius of approximately 5 mm when used to test heating pads and heating panels (see Figure 2). For the test, the cylinder is laid horizontally on the sample and, in the case of a trace heating cable, its axis is placed across the sample. A trace heating cable having a non-circular cross-section shall be so positioned that the impact is applied along the minor axis (i.e. the trace heating cable is positioned flat on the steel plate).

Other than in tests on electrical trace heating intended for use in applications with low risk of mechanical damage, a hammer with a mass of 1 kg shall be allowed to fall once onto the horizontal cylinder from a height of 700 mm (i.e. with an impact load of 7 J).

For trace heating intended for use in applications with a low risk of mechanical damage in accordance with 4.1, the height may be reduced to 400 mm (i.e. an impact load of 4 J). Electrical resistance trace heating submitted to such a test shall be clearly marked as specified in 6.3 to caution the user as to its reduced mechanical capability.

Immediately after impact conformity is verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3 while the steel cylinder and hammer are still in place on the sample. For MI cables, the required test voltage in 5.1.2 is reduced to 2U + 500 V a.c. for cables rated over 30 V a.c., or to $\sqrt{2}$ U + 500 V d.c. for cables rated over 60 V d.c.



Key

1 hammer with mass of 1 kg

2 cylinder with diameter of 25 mm

3 minor axis of non-circular heating cable

4 cylinder with 25 mm overall length and 5 mm radius rounding when used to test heating pads and heating panels

5 height of fall of hammer: 700 mm or 400 mm

Figure 2 – Impact test

5.1.6 Deformation test

A sample is placed on a rigid flat steel plate. A crushing force of 1 500 N is then applied for 30 s, without shock, by means of a 6 mm diameter steel rod with hemispherical ends and a total length of 25 mm. For the test, the rod is laid flat on the sample and in the case of a trace heating cable it is placed across a specimen at right angles. In the case of a pad, it is necessary to ensure that the cylinder rests across the active element.

For electrical trace heating intended for use in applications with low risk of mechanical damage, the crushing force may be reduced to 800 N. Electrical resistance trace heating submitted to such a test shall be clearly marked as specified in 6.3 to caution the user concerning its reduced mechanical capability.

After the deformation load is applied for 30 s, conformity is verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3 while the horizontal steel rod is still in place on the sample and the load applied. For MI cables, the required test voltage in 5.1.2 is reduced to 2U + 500 V a.c. for cables rated over 30 V a.c., or to $\sqrt{2}$ U + 500 V d.c. for cables rated over 60 V d.c.

NOTE Trace heating cable samples need only be approximately 200 mm in length.

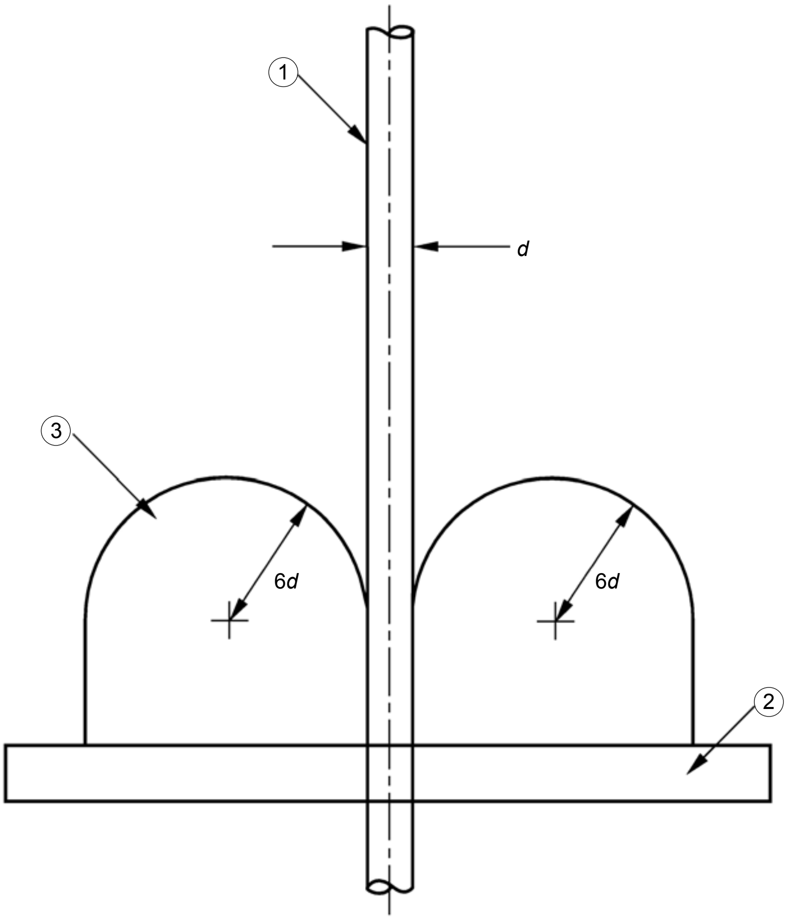
5.1.7 Cold bend test

This test applies only to trace heaters that have a stated minimum bending radius of less than 300 mm.

The system documentation shall state the minimum installation temperature and the minimum bending radius.

The apparatus used for the cold bend test is shown in Figure 3, with the radius of the metal mandrel as shown, or with the radius equal to the manufacturer's stated minimum bend radius. A sample of trace heater, without integral terminations or connections, shall be fixed in the apparatus as shown. The apparatus and sample shall be placed in a refrigerated compartment and maintained at the manufacturer’s minimum recommended installation temperature for a period of not less than 4 h. At the end of this period, the sample shall be bent through 90° around one of the mandrels, then bent through 180° in the opposite direction over the second mandrel and then straightened to its original position. All the bending operations shall be carried out in the same plane. This cycle of operations shall be performed three times.

Conformity is verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3. For MI cables, the required test voltage in 5.1.2 is reduced to $2U$ + 500 V a.c. for cables rated over 30 V a.c., or to $\sqrt{2}\,U$ + 500 V d.c. for cables rated over 60 V d.c.



Key

1 sample trace heater
2 steel base
3 metal mandrel
d = trace heater diameter or primary bending plane unless specified otherwise by the manufacturer

Figure 3 – Cold bend test – Type test

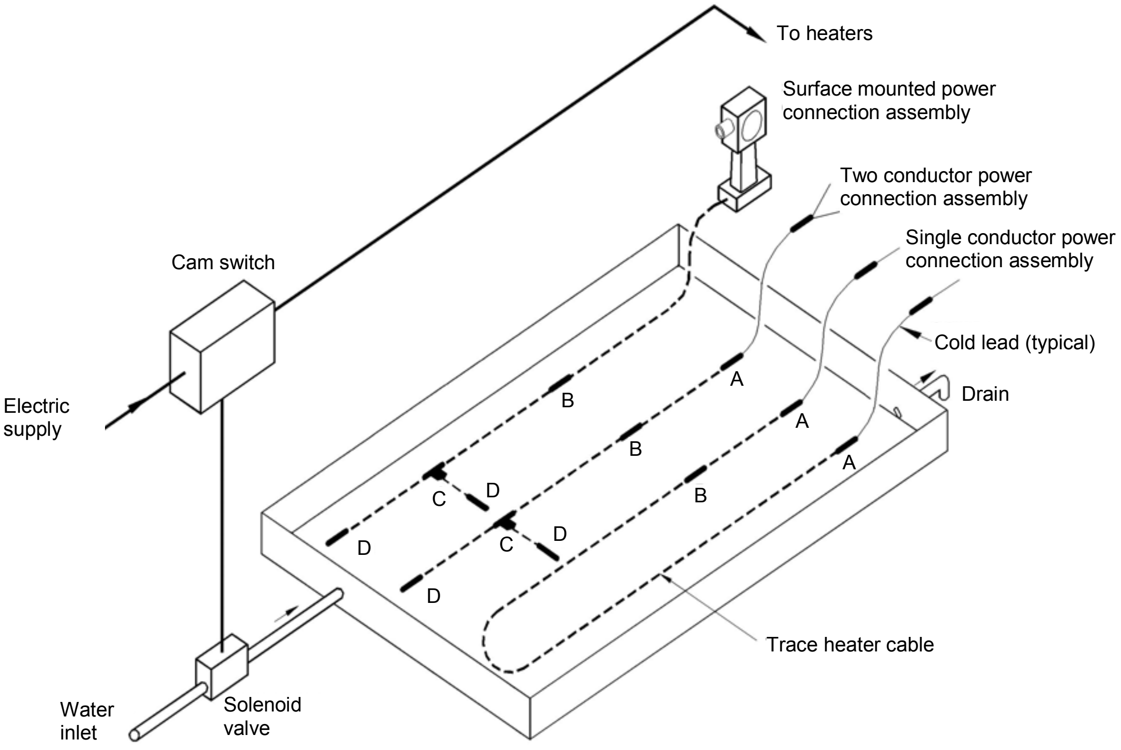
5.1.8 Water resistance test

A sample of trace heater shall be immersed (except at terminations, or ends where the conductors are exposed) in tap water at 10 °C to 25 °C for a period of 14 days.

Conformity is verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3. For MI cables, the required test voltage in 5.1.2 is reduced to $2U$ + 500 V a.c. for cables rated over 30 V a.c., or to $\sqrt{2}\,U$ + 500 V d.c. for cables rated over 60 V d.c.

5.1.9 Integral components resistance to water test

A sample of the trace heater with all integral components shall be placed in a tap water flow and drain apparatus as shown in Figure 4. For heating pads or panels, a unit with cold leads shall be used. Water flow shall be initiated and the sample shall be completely immersed. At that point, the water flow is stopped and the trace heater is energized. The apparatus is then drained. The total time from the initiation of water flow to the completion of draining shall be no greater than 4,5 min and no less than 2,5 min. The trace heater shall continue to be energized for 30 s after the water has been drained. The trace heater is then de-energized and water flow is initiated for the next cycle. The test shall be continued for a period of 24 h. After completion, the dielectric test outlined in 5.1.2 shall be performed. For MI cables, the required test voltage in 5.1.2 is reduced to $2U$ + 500 V a.c. for cables rated over 30 V a.c., or to $\sqrt{2}\,U$ + 500 V d.c. for cables rated over 60 V d.c. The immersed connections of the trace heater shall be inspected to verify no evidence of water ingress.


To heaters
Surface mounted power connection assembly
Two conductor power connection assembly
Single conductor power connection assembly
Cold lead (typical)
Drain
Cam switch
Electric supply
A
A
A
B
B
B
C
C
D
D
D
D
Trace heater cable
Water inlet
Solenoid valve

Key

A integral power connection

B integral splice connection

C integral in-line tee

D integral end termination

Figure 4 – Integral components resistance to water test

5.1.10 Verification of rated output

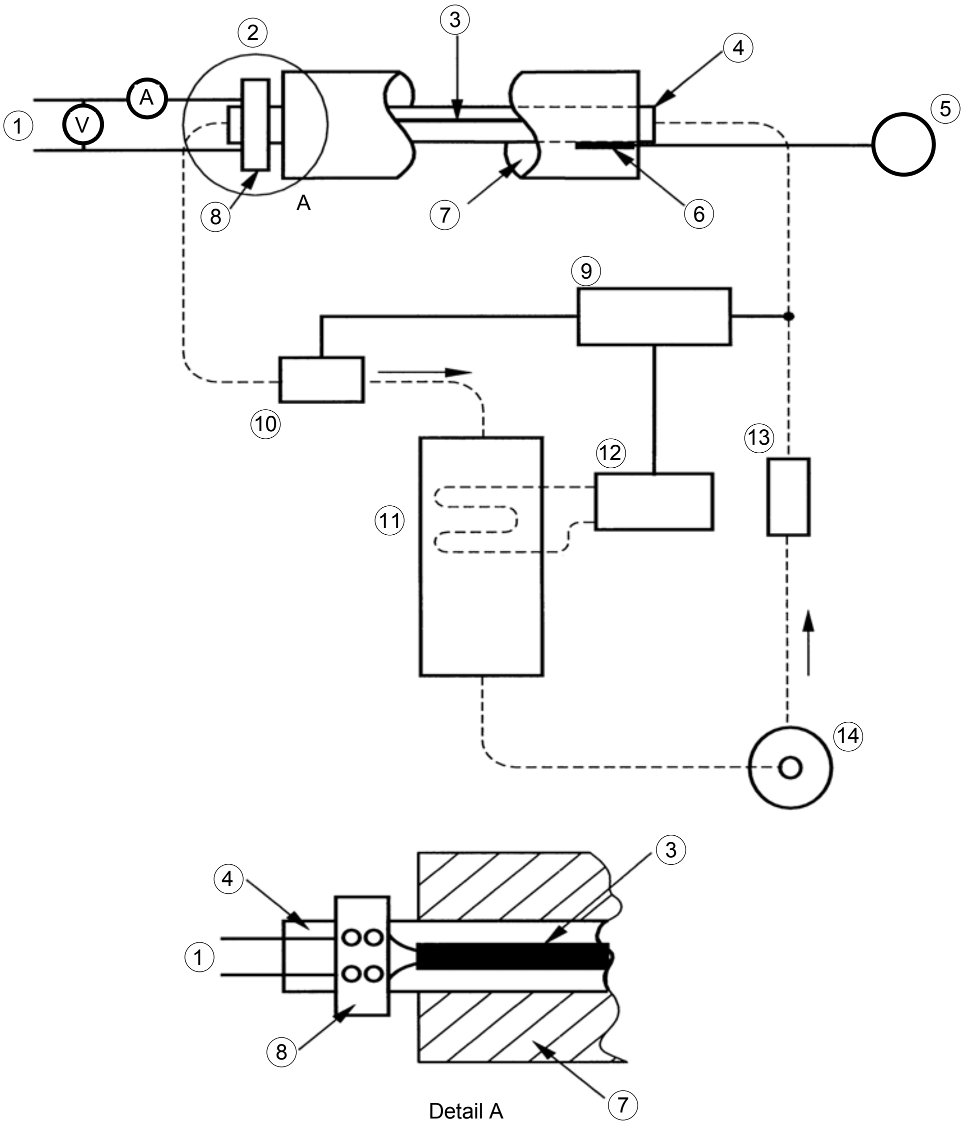
The rated output of the trace heater or heating panel or pad shall be verified by one of the following two methods, as selected by the manufacturer:

a) resistance: the measured d.c. resistance per unit length at a specified temperature shall be within the manufacturer's declared tolerance;

b) thermal: the thermal output of trace heaters is measured by installation of a single sample, 3 m to 6 m in length, on a carbon steel pipe of 50 mm diameter or greater, as shown in Figure 5. The sample is installed in accordance with the manufacturer's instructions. The test apparatus is completely covered with thermal insulation of 25 mm thickness. For heating pads or panels, the test is conducted on a liquid-cooled flat metal plate with 25 mm of thermal insulation installed over the surface of the heating pad or panel.

   A suitable heat-transfer liquid is circulated through the pipe at a sufficient rate to establish turbulent flow such that there is a negligible temperature difference between the fluid and the pipe. The heat-transfer fluid is maintained at a constant temperature. These parameters are verified by thermocouples placed at the entry and exit ends of the pipe. Flow velocity shall be such that the fluid temperature does not differ by more than 2 K from end to end.

   The thermal output of the trace heater is measured at three pipe temperatures representative of the full operating range. The trace heater is powered at its rated voltage and allowed to attain equilibrium. The voltage, current and liquid temperatures, and sample length are recorded at each test temperature. Three separate determinations are made on separate samples. The resulting values shall be within the manufacturer's declared tolerance.



Key

1	controlled voltage source
2	see detail A
3	trace heater
4	50 mm outside diameter or greater test pipe
5	temperature indicator
6	thermocouple
7	fibre glass insulation, 25 mm minimum thickness and a density of approximately 3,25 kg per cubic metre
8	electrical terminals
9	temperature controller
10	in-line heater
11	heat exchanger
12	chilling unit
13	flow meter
14	pump

Figure 5 – Verification of rated output

5.1.11 Thermal stability of electrical insulating material

The thermal stability of the electrical insulating materials of trace heaters shall be verified on a sample or prototype after it has been stored at a temperature of the manufacturer's declared maximum withstand temperature +20 K, but not less than 80 °C, for at least four weeks. Compliance of the sample or prototype shall be verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3. For MI cables, the required test voltage in 5.1.2 is reduced to $2U$ + 500 V a.c. for cables rated over 30 V a.c., or to $\sqrt{2}\,U$ + 500 V d.c. for cables rated over 60 V d.c.

Terminations that insure the vapour tightness of trace heaters made of hygroscopic materials (for example the cold end seals of MI cable sets) are subjected to a temperature of (80 ± 2) °C for 4 weeks at not less than 90 % R.H. Compliance of the sample or prototype shall be verified by testing the electrical insulation in accordance with 5.1.2 and 5.1.3. For MI cables, the required test voltage in 5.1.2 is reduced to $2U$ + 500 V a.c. for cables rated over 30 V a.c., or to $\sqrt{2}\,U$ + 500 V d.c. for cables rated over 60 V d.c.

5.1.12 Thermal safety requirements

In explosive gas atmospheres, it is critical to ensure that the maximum surface temperature of a trace heater is lower than the ignition temperature of the explosive gas atmosphere. The manufacturer's quality program shall demonstrate the thermal safety of trace heating products with respect to time.

5.1.13 Determination of maximum sheath temperature

5.1.13.1 General

NOTE In explosive gas atmospheres, it is critical to ensure that the maximum sheath temperature for trace heaters is less than the ignition temperature of the explosive gas atmosphere. The maximum sheath temperature is dependent on the trace heater power density, overall heat-transfer coefficient, and the maximum possible temperature of the surface to be heated. These factors are used by the manufacturer to determine the sheath temperatures of the trace heaters.

Maximum sheath temperatures of trace heaters shall be determined to ensure the safe use of the heater(s). These sheath temperatures shall not exceed the temperature class, the maximum exposure temperatures of the workpiece material, the trace heater material and the thermal insulation.

The maximum allowable power density and sheath temperatures declared by the manufacturer shall be tested by one of the following two methods:

a) a systems approach (see 5.1.13.2), used to validate a manufacturer's design methodology and calculations, in which the trace heater is subjected to a test condition where the manufacturer demonstrates ability to design and predict sheath temperatures by conducting specific tests;

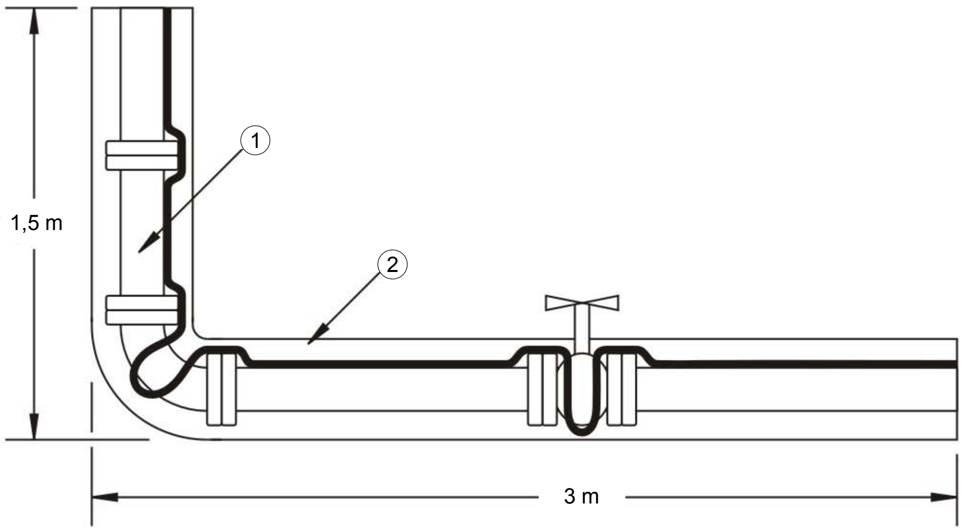
b) a product classification (see 5.1.13.3) approach in which the maximum sheath temperatures are generated in an artificial environment simulating worst-case conditions.

5.1.13.2 Systems approach, design verification method

5.1.13.2.1 For trace heaters, the test apparatus (see Figure 6) shall consist of a 3 m horizontal run and a 1,5 m vertical run of piping having a pipe size between 50 mm and 150 mm diameter. A flanged gate valve or equivalent (butterfly valve, globe valve, etc.) shall be located in the centre of the horizontal run. The vertical run shall be so arranged that the flanged pipe ends are in the centre. The trace heater shall be installed in a manner consistent with the manufacturer's installation instructions. Thermocouples shall be used to monitor the pipe and valve surface temperatures and the trace heater sheath temperatures. The thermocouples shall be located at anticipated hotspots. The piping system shall be insulated with a minimum of 25 mm thickness of thermal insulation and installed in accordance with the manufacturer's installation procedures. Pipe ends shall be plugged and thermally insulated. Unless a higher temperature is specified, the ambient temperature shall not exceed 40 °C. The trace heater shall be powered at 110 % of its rated voltage. System temperatures shall be allowed to stabilize and thermocouple readings recorded. The measured sheath temperatures shall not exceed the manufacturer's calculated value by more than 10 K, and in no case shall they exceed the temperature determined in accordance with 4.4.1.

5.1.13.2.2 For pads, panels and other surface trace heaters, a representative section shall be applied to a 6 mm thick steel plate in accordance with the manufacturer's instructions. The steel plate shall not extend more than 25 mm from any edge of the surface trace heater. The thermocouples shall be located at any anticipated hotspots. The heated side of the plate shall be insulated with a minimum of 25 mm of thermal insulation. The plate is then located in a stable room-temperature environment in a vertical orientation. The surface trace heater shall be powered at 110 % of rated voltage. After stabilization, the thermocouple readings shall be recorded including ambient temperature. The measured surface temperatures shall not exceed manufacturer's calculated values by more than 10 K.

5.1.13.2.3 Alternative and/or additional simulated operating conditions may be considered.



Key

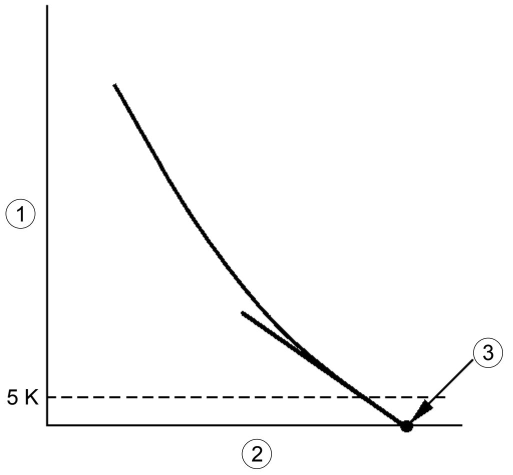
1 50 mm to 150 mm nominal pipe bore

2 fibre glass insulation, 25 mm minimum thickness and a density of approximately 3,25 kg per cubic metre

Figure 6 – Verification of sheath temperature using system approach

5.1.13.3 Product classification approach

A sample of trace heater at least 1,5 m in length is placed, loosely coiled, in a forced-air-circulation oven. The sample shall be within the upper half of the trace heater's thermal output tolerance. Representative thermocouples shall be used to monitor sample sheath temperatures and shall be placed 500 mm from each end. One additional thermocouple is used to monitor the temperature within the oven. The trace heater shall be energized at 110 % of rated voltage. The oven ambient temperature shall be raised from ambient temperature in 15 K increments. Sufficient time shall be permitted at each temperature to allow for the oven temperature and the trace heater sheath temperature to stabilize and attain thermal equilibrium. Oven and trace heater sheath temperatures shall be recorded at each successive level until the difference (ΔT) between the two is 5 K or less. A curve shall be drawn from the test data, and a straight line drawn tangentially to the curve at the 5 K temperature difference point and extended to 0 K. The temperature read at this intercept shall be taken as the maximum sheath temperature, as shown in Figure 7.



Key

1 sample temperature minus oven air temperature ($T_s - T_o$), K

2 oven temperature (T_o), °C

3 recorded value of T_s, °C

Figure 7 – Maximum sheath temperature using the product classification approach

5.1.14 Verification of start-up current

The start-up current of the trace heater shall be measured as a function of the minimum ambient temperature, as designated by the manufacturer. A sample of trace heater, at least 1 m in length, shall be installed in accordance with the manufacturer’s instructions on a minimum 50 mm diameter, liquid-filled steel pipe or solid rod, or for heating panels or pads a flat metal heat sink. The testing apparatus shall be completely covered with thermal insulation and conditioned at the minimum ambient temperature for at least 4 h.

NOTE The apparatus described in 5.1.10 can be used for this test.

After the conditioning period, rated voltage shall be applied and the time/r.m.s. current characteristic shall be recorded from time zero to 300 s. The start-up current recorded shall be the highest current response of three samples. This time-current characteristic shall not be more than the value declared by the manufacturer.

5.1.15 Verification of the electrical resistance of metallic covering

The electrical resistance of the metallic covering of at least a 3 m length of trace heater shall be measured at 10 °C to 40 °C. A representative sample of a heating panel or pad shall be used. The resistance shall be equal to, or less than, the manufacturer’s declared value.

5.2 Routine tests

5.2.1 Dielectric test

Each supplied length, item, or assembly, whether in bulk or individually fabricated items, shall be subjected to the dielectric test specified in 5.1.2, except that the test voltage for MI shall be $2U$ + 500 V a.c. for cables rated over 30 V a.c., or $\sqrt{2}\,U$ + 500 V d.c. for cables rated over 60 V d.c.

The polymeric sheath (overjacket) used for corrosion resistance over the metallic braiding or continuous metallic covering shall be subjected to the dielectric test of 1 000 V a.c. whilst immersed in water. As an alternative to immersing in water, the electrical insulation of trace heaters may be subjected to a dry spark test, with a minimum test voltage of 3 000 V a.c. r.m.s. that has a substantially sinusoidal waveform at 2 500 Hz to 3 500 Hz. For a 3 000 Hz supply, the rate of travel of the trace heater through the dry test device, in metres per second, shall not be more than 3,3 times the length of the electrode measured in centimetres.

5.2.2 Verification of rated output

The output rating for each manufactured length of parallel trace heater shall be verified for linearity of power output through continuous or statistical test methods. The power output rating for each length of series resistance trace heater or fixed resistive trace heater shall be verified by measurement of the d.c. resistance, or conductance or current at rated voltage and given temperature. The test measurement criteria shall be established or correlated to the output verification test specified in 5.1.10. If statistical methods are used, the results shall represent a total product reliability of 95 % or greater. The power output shall show that the power output is measured and is within the manufacturer's declared tolerances with a 95 % confidence level.

6 Marking

6.1 Product markings for trace heaters

Trace heaters shall be clearly and permanently surface marked in accordance with IEC 60079-0 and shall additionally include the following information. For trace heaters with factory-fabricated terminations, or surfaces where legible printing cannot be applied, the marking shall be on a durable tag/label permanently affixed within 75 mm of the power connection fitting or gland.

a) the symbol provided for the type of protection used for trace heating shall be "e" for increased safety, which does not preclude the use of additional types of protection appropriate for the components intended to be supplied or recommended for use with the trace heaters;

b) the required serial number or batch number may be substituted with the month and year of manufacture, date coding, or equivalent;

c) the rated or operating voltage for parallel cable, or the maximum operating voltage for series cable;

d) the rated power output per unit length at the rated voltage (and at a stated reference temperature for devices that change output with temperature), or the resistance in ohms for unit length for series cable, or the operating current or total wattage as applicable.

6.2 Markings for field-assembled components

Field-assembled components that are accessible after installation shall be marked in accordance with IEC 60079-0 and shall additionally include the following information. In the case of components with small surface areas or surfaces where legible printing cannot be applied, the markings may be placed on the smallest unit container in lieu of the component itself.

a) the month and year of manufacture, date coding, applicable serial number, or equivalent;

b) applicable environmental requirements, such as IP (ingress protection) ratings, and area use requirements.

6.3 Installation instructions

The manufacturer shall provide product specific installation instructions for trace heaters and components. Instructions for various components and trace heaters may be combined where termination/installation instructions are identical. The instructions shall be clearly identified as to the products and locations that apply, and shall include the following information.

Any special conditions for safe use, including the provision in item f) below, shall be outlined in the installation instructions and in the certificate of conformity, and the product and the certificate shall be marked with the symbol “X”.

The information for the instructions include:

a) the intended use;

b) the statement “Suitable for use with” (or equivalent) and a listing of applicable trace heaters, or a listing of applicable connection fittings, as applicable;

c) the statement “Ground fault equipment protection is required for each circuit”;

d) the statement “De-energise all power circuits before installation or servicing”;

e) the statement “Keep ends of trace heaters and kit components dry before and during installation”;

f) for trace heaters investigated for reduced levels of impact and/or deformation, the statement “Caution: Only use in areas with low risk of mechanical damage”;

g) for trace heaters, the statement “The metal sheath/braid of this trace heater must be connected to a suitable earthing terminal”;

h) the statement “The presence of the trace heaters shall be made evident by the posting of caution signs or markings at appropriate locations and/or at frequent intervals along the circuit”.

NATIONAL ANNEX A

(*National Foreword*)

A-1 BIS CERTIFICATION MARKING

The product may also be marked with the Standard Mark.

A-1-1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60079 - 0 : 2004[1] Electrical apparatus for explosive gas atmospheres — Part 0 : General requirements	IS/IEC 60079-0 : 2004 Electrical apparatus for explosive gas atmospheres: Part 0 General requirements	Identical
IEC 60079-7 : 2001 Electrical apparatus for explosive gas atmospheres — Part 7: Increased safety 'e'	IS 6381 : 2004[2] Electrical apparatus for explosive gas atmospheres — Increased safety "e"	do
IEC 60079-10 : 2002 Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas	IS 5572 : 2009 Classification of hazardous areas (other than mines) having flammable gases and vapours for electrical installation	Modified
IEC 60079-30-2 Explosive atmospheres — Part 30-2: Electrical resistance trace heating — Application guide for design, installation and maintenance	IS/IEC 60079-30-2 : 2007 Explosive atmospheres: Part 30 Electrical resistance trace heating, Section 2 Application guide for design, installation and maintenance	Identical to IEC 60079-30-2 : 2007
IEC 60364-5-55 Electrical installations of buildings — Part 5-55: Selection and erection of electrical equipment — Other equipment	SP 30 : 2010 National Electrical Code	Technically Equivalent

Only the English language text of the International Standard has been retained while adopting it in this Indian Standard, and as such the page numbers given here are not the same as in the IEC Publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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[1] Since revised in 2007.

[2] Superseded by IS/IEC 60079-7 : 2006 'Explosive atmospheres: Part 7 Equipment protection by increased safety "e" '.

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This Indian Standard has been developed from Doc No.: ETD 22 (6266).

Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

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